Functions

• Concept of functions
• Functions you already know
• Pre-written vs. user-defined functions
• Parts of a function
What’s a Function

Mathematically:
for every input, there is exactly one output
i.e., \( y \) is unique

input \( \rightarrow \) \( y = f(x) \) \( \rightarrow \) output
Example - algebra

input (eval for $x = 4$)

$y = x^2 + 2 \times x - 1$;

output
input (eval for x = 4)

\[ y = x^2 + 2 \times x - 1; \]

output

(y = 23)
Functions in Programming

- A function
  - is a section of a program
  - that can act on data and
  - return a value
A function

- has a name used to call the function

- upon "call" program execution jumps to the 1^{st} statement of the fn and continues until "return" statement

- it "returns" to the place it was called from
To use a fn – just "call" it

- "called" by its name

- \( y = 2 + \sqrt{25} \);
What Actually Happens

\[ y = 2 + \sqrt{25}; \]

function call

\[ \sqrt{25} \]

calculate

return the value

it's 5
What Actually Happens

\[ y = 2 + \sqrt{25}; \]

\[ \sqrt{25} \]

return the value

calculate

\[ \text{sqrt}(25) \]
Why functions ???

- To avoid code duplication
Why functions???

- To avoid code duplication
  - Say, \( f(x) = x^2 + 3x + 2 \)
  - \( f(1) + f(4) + f(7) \)
To avoid code duplication

Say, \( f(x) = x^2 + 3x + 2 \)

\[ f(1) + f(4) + f(7) \]

vs.

\[ (1*1+3*1+2) + (4*4+3*4+2) + (7*7+3*7+2) \]
Why functions ???

- To avoid code duplication
- To better structure code
  - Easier to develop
  - Easier to read
  - Easier to maintain
  - Easier to test
Why functions ???

- To avoid code duplication
- To better structure code
- To write recursive code
What to do with what you get Back – OSU it

- **Output it**
  - `cout << sqrt(4);`
- **Save it**
  - `y = sqrt(4);`
- **Use it**
  - `y = (-b + sqrt(b*b - 4*a*c)) / (2*a)`
Not OSU it -- Doesn’t get you much

\[ \sqrt{4}; \quad // \text{not printed} \]
\[ \quad // \text{not saved} \]
\[ \quad // \text{not used} \]

But legal
#include <cmath>

- sqrt(x) - return square root of x
- ceil(x) - return rounded up value of x
- floor(x) - return rounded down value of x
- fabs(x) - returns floating abs value of x  
  i.e., x is double or float NOT int
- pow(x,y) - returns x raised to power of y
- exp(x) - returns e raised to power of x

- google: C++ cmath
Trig fns - `#include <cmath>`

Note: \( x \) is in radians

- \( \sin(x) \) \( \rightarrow \) \( \text{asin}(x) \)
- \( \cos(x) \) \( \rightarrow \) \( \text{acos}(x) \)
- \( \tan(x) \) \( \rightarrow \) \( \text{atan}(x) \)
- \( \cot(x) \) \( \rightarrow \) \( \text{acot}(x) \)
- \( \sec(x) \) \( \rightarrow \) \( \text{asec}(x) \)
- \( \csc(x) \) \( \rightarrow \) \( \text{acsc}(x) \)
#include <cstdlib>

- int abs (int n)
- returns the absolute value of an integer value
#include <algorithm>

- **min** returns lesser of 2 arguments
- **max** returns greater of 2 arguments

```cpp
cout << min(3, 5) << " " << max(42, -5) << endl;
```
How do you know it’s a fn?

- Look for the () immediately following identifier
  - sqrt (7)
How do you know it’s a fn?

- Look for the () immediately following identifier
  - sqrt (7) fn
  - cout << sqrt(4)
How do you know it’s a fn?

- Look for the () immediately following identifier
  - sqrt (7) fn
  - cout << sqrt(4) fn
  - cos( 0.4 )
How do you know it’s a fn?

- Look for the () immediately following identifier

- `sqrt(7)`  
- `cout << sqrt(4)`  
- `cos(0.4)`  
- `sin(pi/2)`
How do you know it’s a fn?

- Look for the () immediately following identifier

- sqrt (7) fn
- cout << sqrt(4) fn
- cos(0.4) fn
- sin (pi/2) fn
- tan *(3)
How do you know it’s a fn?

- Look for the () immediately following identifier

- sqrt (7) fn
- cout << sqrt(4) fn
- cos( 0.4 ) fn
- sin (pi/2) fn
- tan *( 3 ) NOT fn
Write a program that:
- Prompts the user for a radius
- Prints area & circumference of circle with that radius
Solution:

```cpp
#include <iostream>
#include <cmath>

using namespace std;

int main()
{
    double radius;
    cout << "Enter radius: ";
    cin >> radius;
    double PI = acos(-1.0);
    cout << "Area of circle is: " << PI * radius * radius << endl;
    cout << "Circumference of circle is: " << 2 * PI * radius << endl;
    return 0;
}
```
#include <iostream>

#include <cmath>

using namespace std;

int main()
{
    double PI = acos(-1.0);

    cout << "Enter radius: ";

    double radius;
    cin >> radius;

    cout << "Area of circle is: " << PI * radius * radius << endl;

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Solution:

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    cin >> radius;

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Solution:

```cpp
#include <iostream>

using namespace std;

int main()
{
    double radius;
    cout << "Enter radius: ";
    cin >> radius;

    cout << "Area of circle is: "
        << PI * radius * radius << endl;

    return 0;
}
```
# include <iostream>

using namespace std;

int main()
{
    double radius;
    cout << "Enter radius: ";
    cin >> radius;

    cout << "Area of circle is: "
         << PI * radius * radius << endl;
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    return 0;
}
#include <iostream>
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int main()
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#include <iostream>
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    cout << "Area of circle is: "
         << PI * radius * radius << endl;
    cout << "Circumference of circle is: "
         << 2 * PI * radius << endl;

    return 0;
}
```
Exercise

- Write a program that:
  - Prompts the user for a radius
  - Prints area & circumference of circle with that radius
  - Prints volume & surface area of sphere with that radius
    - Volume of sphere is: $\frac{4}{3} \pi r^3$
    - Surface area of sphere is: $4\pi r^2$
#include <iostream>
#include <cmath>
using namespace std;

int main()
{
    double radius;
    cout << "Enter radius: ";
    cin >> radius;

    double PI = acos(-1.0);

    cout << "Area of circle is: 
    " << PI * radius * radius << endl;
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    " << 2 * PI * radius << endl;

    return 0;
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Solution:

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#include <iostream>
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    cout << "Circumference of circle is: 
        " << 2 * PI * radius << endl;

    cout << "Surface area of sphere is: 
        " << 4 * PI * radius * radius << endl;

    return 0;
}
```
#include <iostream>
#include <cmath>
using namespace std;

int main()
{
    double radius;
    cout << "Enter radius: ";
    cin >> radius;

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         << 4 * PI * radius * radius << endl;

    return 0;
}
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    cout << "Surface area of sphere is: 
        << 4 * PI * radius * radius << endl;

    return 0;
}
```
Solution:

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using namespace std;

int main()
{
    double radius;
    cout << "Enter radius: ";
    cin >> radius;

    double PI = acos(-1.0);
    double area = PI * radius * radius
    cout << "Area of circle is: 
        " area << endl;
    cout << "Circumference of circle is: 
        " 2 * PI * radius << endl;

    cout << "Surface area of sphere is: 
        " 4 * area << endl;

    return 0;
}
```
#include <iostream>
#include <cmath>
using namespace std;

int main()
{
    double radius;
    cout << "Enter radius: ";
    cin >> radius;

    double PI = acos(-1.0);
    double area = PI * radius * radius;
    cout << "Area of circle is: " << area << endl;
    cout << "Circumference of circle is: " << 2 * PI * radius << endl;
    
    cout << "Volume of sphere is: " << 4 * PI * pow(radius, 3) / 3 << endl;
    cout << "Surface area of sphere is: " << 4 * area << endl;

    return 0;
}
Solution:

```cpp
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    double area = PI * radius * radius;
    cout << "Area of circle is: "
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    cout << "Circumference of circle is: "
    << 2 * PI * radius << endl;

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    << 4 * PI * pow(radius, 3) / 3 << endl;

    cout << "Surface area of sphere is: "
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    cout << "Surface area of sphere is: "
         << 4 * area << endl;

    return 0;
}
Exercise

- Write a program that:
  - Prompts the user for length, width, height of a room
  - Prints how much paint needed to paint the room
  - Paint covers 200 sq ft per gallon
  - It will take 2 coats
  - Only the walls of the room need to be painted
#include <iostream>

using namespace std;

int main()
{
    double length, width, height;
    cout << "Enter length, width, height of your room: " << endl;
    cin >> length >> width >> height;
    double wallArea = 2 * height * (length + width);
    int paint = ceil(2 * wallArea / 200);
    cout << "Paint needed is: " << paint << " gallons";
    return 0;
}
#include <iostream>

using namespace std;

int main()
{
    cout << "Enter length, width, height of your room:" << endl;

    return 0;
}
```cpp
#include <iostream>

#include <cmath>

using namespace std;

int main()
{
    double length, width, height;
    cout << "Enter length, width, height of your room:" << endl;
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```
# Solution:

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using namespace std;

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